Contributions to marine science by fishery observers in the French EEZ of Kerguelen

by

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ABSTRACT. - All-year round, seven fishing vessels operate in the French EEZ of Kerguelen Islands. Observers employed by TAAF collect data on board fishing vessels for management purposes. This paper is an overview of the observer's scientific work and their important contribution to science from this remote area.

RÉSUMÉ. - Contribution des contrôleurs de pêches aux connaissances scientifiques dans la ZEE française de Kerguelen.

Sept navires pêchent toute l'année dans la ZEE française des îles Kerguelen. Les observateurs employés par les TAAF récoltent des données à bord des navires pour la gestion de la pêche. Cet article donne une vue d'ensemble sur leur travail et l'importance de cet apport aux connaissances scientifiques dans cette région éloignée de tout.

Key words. - Kerguelen - Observer - Patagonian toothfish - Photoidentification - Database - Fishery.

For management purposes, observers were employed by Terres Australes et Antarctiques Françaises (TAAF) to collect data on board French fishing vessels. This paper is a brief and basic overview of the observers' scientific work conducted in the Exclusive Economic Zone (EEZ) around the Crozet and Kerguelen Islands.

Seven fishing vessels are actually working in the French EEZ, with 30 people working on board each vessel all year round. Cruises are three months long which leads to a total of 2000 person days at sea each year. These vessels target Patagonian toothfish (*Dissostichus eleginoides* Smitt 1898) that can grow to more than two meters, but the bulk of the catch

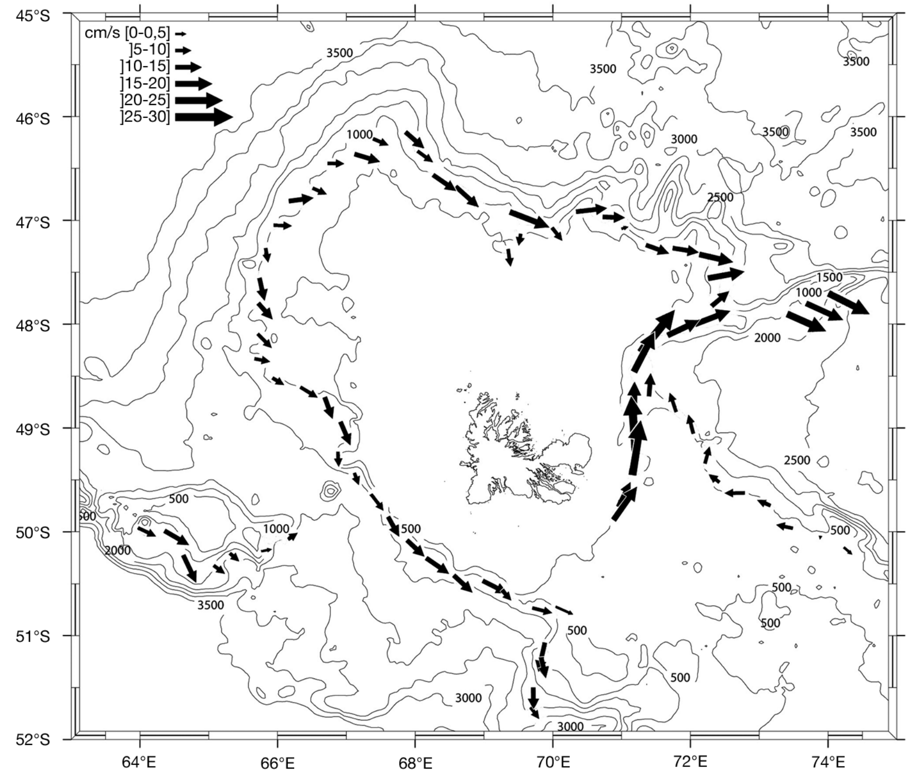

Figure 1. - Current direction and intensity observed from longline drifts on the boundaries of the northern part of the Kerguelen Plateau (Park *et al.*, 2008; modified).

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The Kerguelen Plateau: marine ecosystem and fisheries: 93-98.

is between 70 and 90 cm. The fish is caught by longline only: hooks are attached to a long line set on the bottom. Lines are generally 10 km long and spaced at 1.2 m. Lines are linked to a buoy on the surface so that it can be retrieved, with set times typically over 24 hours. Fishing activity occurs on the slope between 500 and 2 000 m depth. Waters shallower than 500 m are prohibited for conservation reasons.

Scientific and commercial catch and effort data are collected by fishing observers employed by the TAAF. Coverage is 100% over this fishery meaning that no fish is caught without an observer on board. All data are entered into a logbook based on Microsoft Excel®, and submitted to the Muséum national d'histoire naturelle (MNHN) in Paris. Data flow is 6 000 Excel® cells per day, totalling to more than 2 million cells a year.

Different types of data are currently collected from longliners, and the most important are going to be discussed as follows: fishing gear, catch sampling, tagging, biological sampling, birds and mammals.

Fishing gear

Approximately 4 000 longlines are deployed each year, with the position and depth, date and time of each set and haul recorded. Positions and times have been used to describe a new method to measure current using the drift of anchors (Fig. 1) from surface to the bottom (Park *et al.*, 2008). The results match with literature derived from other sources such as remote sensing data.

Catches

Catches are composed of fish and many invertebrates (Fig. 2) including squids, crustaceans, echinoderms and corals. Hooks are obviously not an efficient sampling method for most of the invertebrates but the huge number of hooks deployed leads to opportunities for the collection of data on deep-sea fauna.

Individuals from each species are brought back to MNHN to be recorded and registered in the reference collections. A field guide has been produced for fishes (Duhamel *et al.*, 2005). From the geographical position of lines we obtain the distribution maps (Fig. 3), and the bathymetric distribution (Fig. 4) for different taxa.

Part of the catch is measured by observers, representing 100 000 length measurements per year, allowing length frequency distributions to be produced for target and bycatch species (Fig. 5).

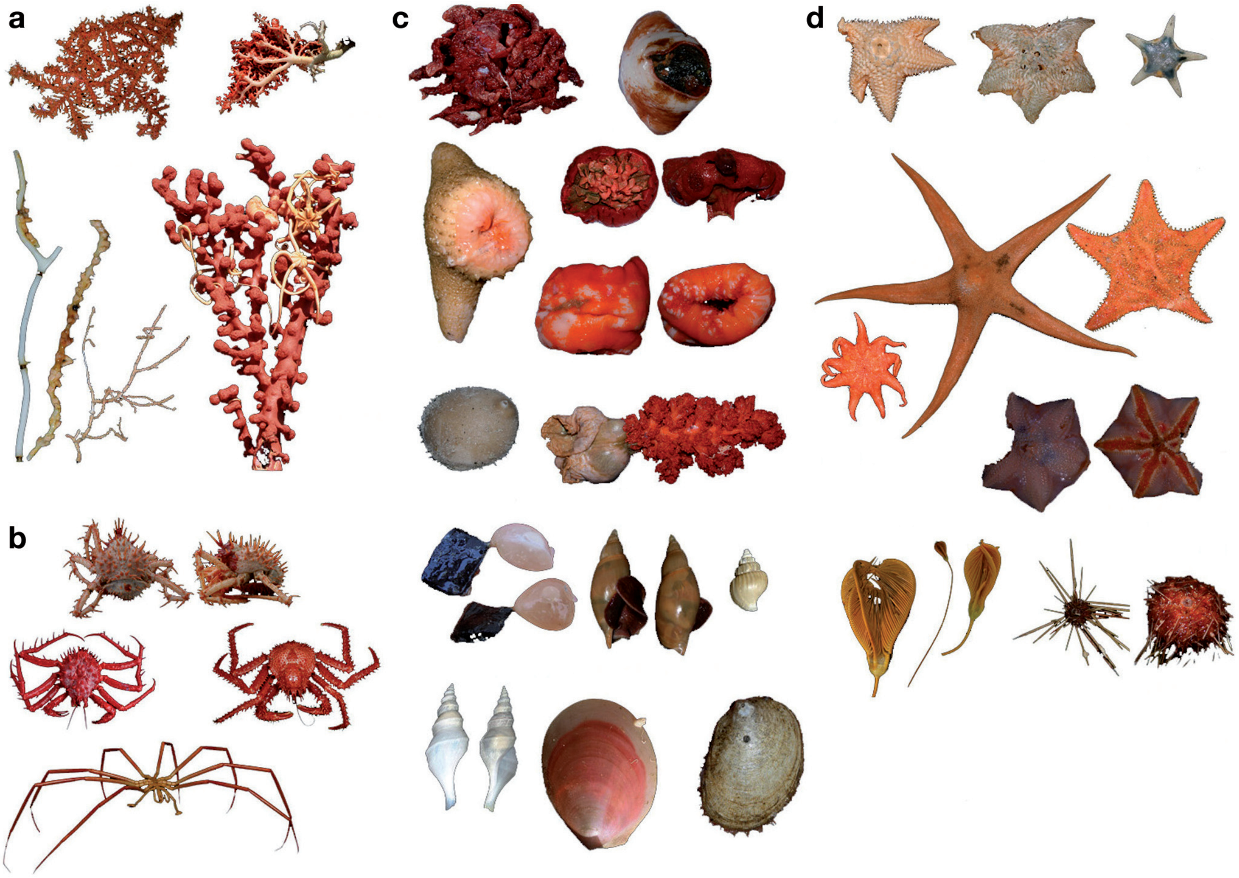

Figure 2. - Examples of invertebrates collected by hooks as by-catch during longline fishing (**a**: Cnidaria, **b**: Arthropoda, **c**: Mollusca, **d**: Echinodermata) in the Kerguelen EEZ.

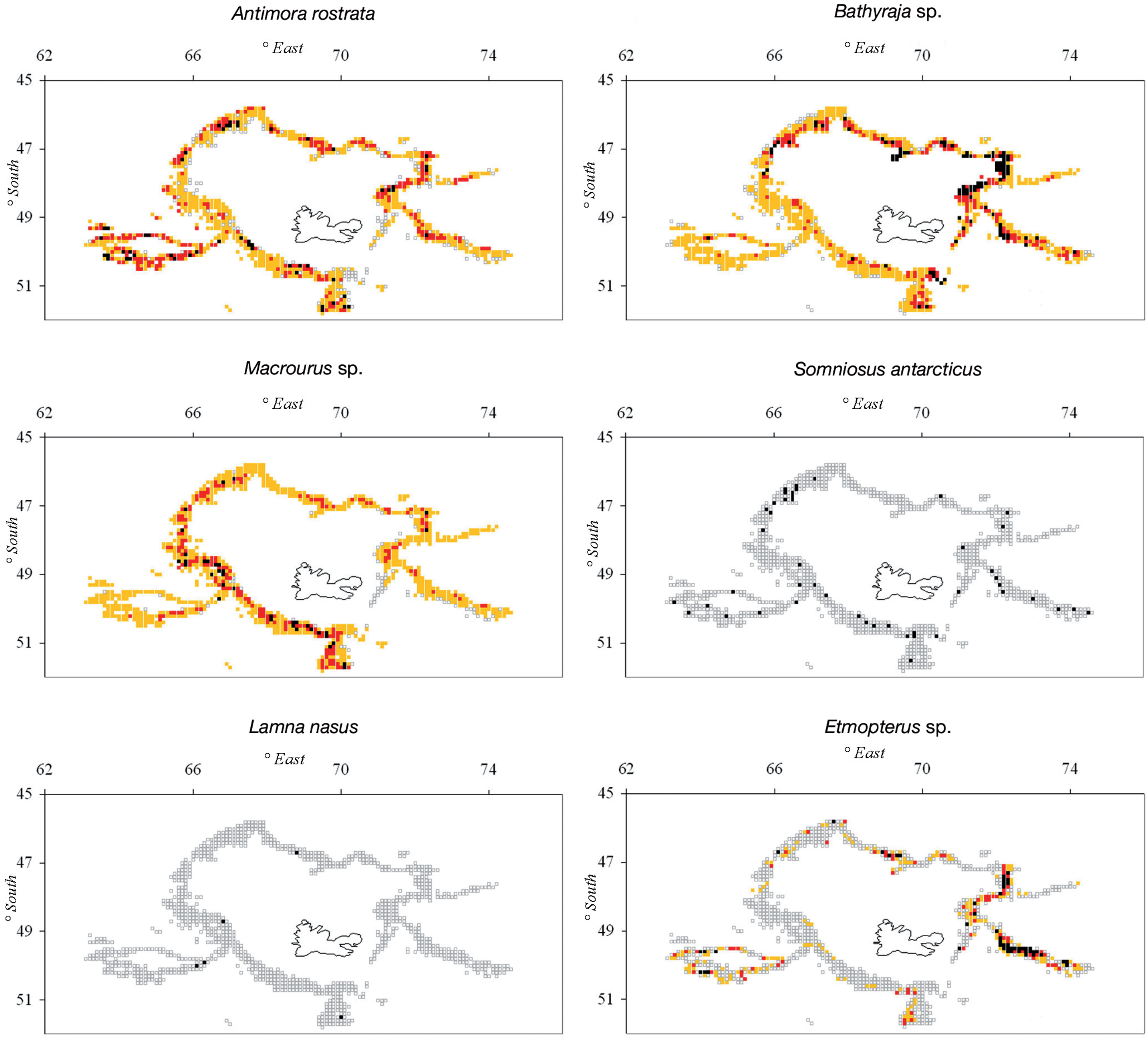

Figure 3. - Example of different bycatch fish species distribution derived from longline fisheries observer data in the Kerguelen EEZ for four successive seasons from 2006 to 2009. Data is plotted as 0.2° grid cells, with black squares for highest, red for intermediate, yellow for lowest and grey squares for zero densities.

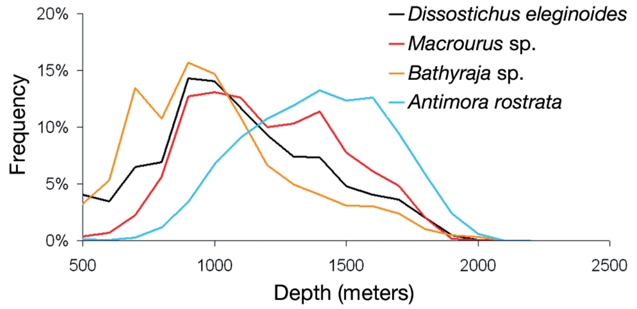

Figure 4. - Example of bathymetric distribution for different fish species derived from longline fisheries observer data in the Kerguelen EEZ.

Tagging

The observers attach uniquely numbered plastic tags to identify a fish before they release it. The tagging rate is around one fish per ton so ~5 000 fish are tagged each year at Kerguelen.

Recaptures of tagged fish give information on movement of the fish around (Fig. 6) and outside the plateau.

Biological sampling

Otoliths, found inside the head of the fish, just behind the eyes, are layered accretion of combined gelatinous matrix and calcium carbonate, and as with annual rings found in

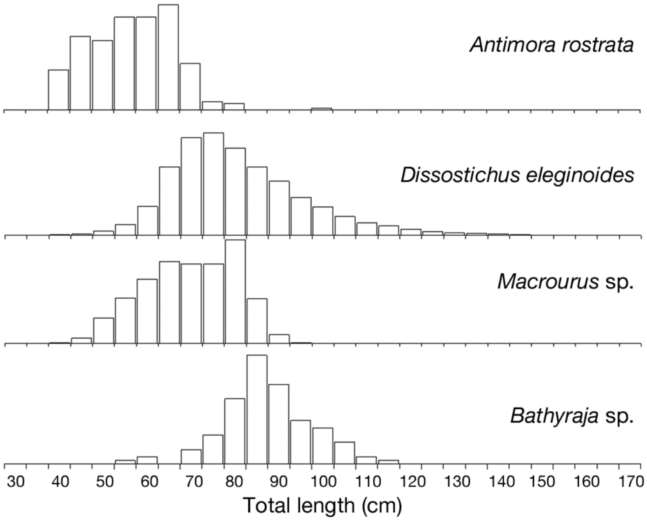

Figure 5. - Length frequency distributions for different fish species derived from longline fisheries observer data in the Kerguelen EEZ.

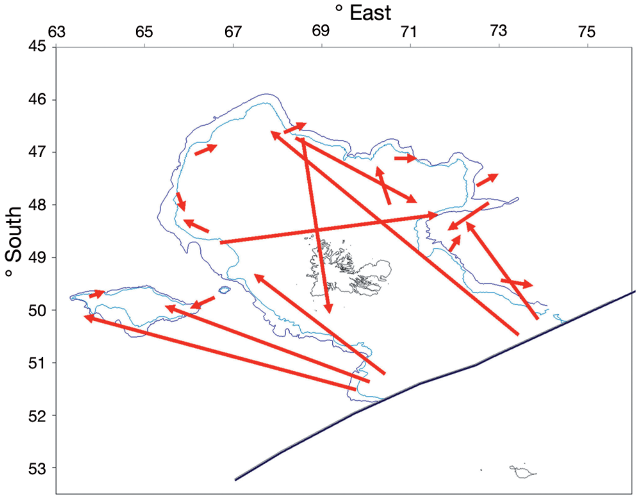

Figure 6. - Map of fish movement (red arrows) obtained from tagging information. Land, 1 000 m and 1 500 m isobaths are represented by thin lines; thick dark blue line represents the boundary between the French (north) and Australian (south) EEZ.

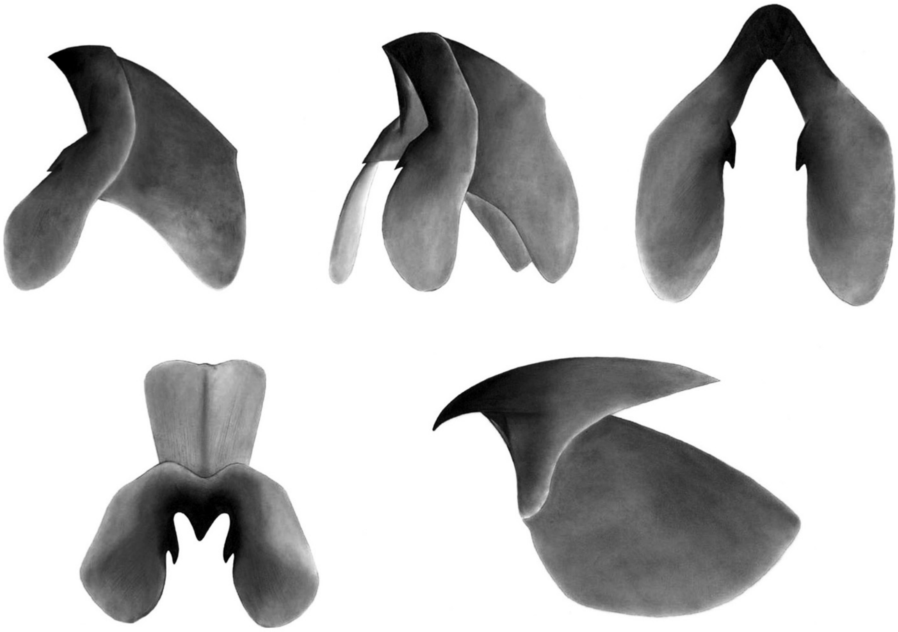

Figure 7. - Cephalopod beaks identification plate, *Oegopsida sp A*. (drawing by N. Gasco from Cherel *et al*., 2004).

trees, it is possible to count the growth layers in the otoliths to age the fish. Observers collect these from toothfish and the main bycatch species. Observers also sample muscle tissue from different fishes and crustaceans for DNA barcoding (currently used to validate the identification of species) and carbon/nitrogen isotopes analyses (used to know the trophic level of species). The current rate of sampling is approximately 120 per year.

The beaks are the most resistant part of the cephalopods found in the stomach contents of toothfish and large sharks; stomach contents like these beaks provide further understanding of this fauna (Cherel and Duhamel, 2003, 2004). The shape of beaks is specific to the species so this gives a lot of information on diet and presence of species in the area, while providing material for reference collections. About 100 samples are collected each year. Both Giant squid (*Architeuthis dux* Steenstrup 1857) and Colossal squid (*Mesonychoteuthis hamiltoni* Robson, 1925) are known to exist in the Kerguelen area due to these samples (Cherel *et al.,* 2004). Identification plates have also been produced out of this work (Fig. 7).

Bird abundance

Many seabirds are attracted to fishing vessels. Observers

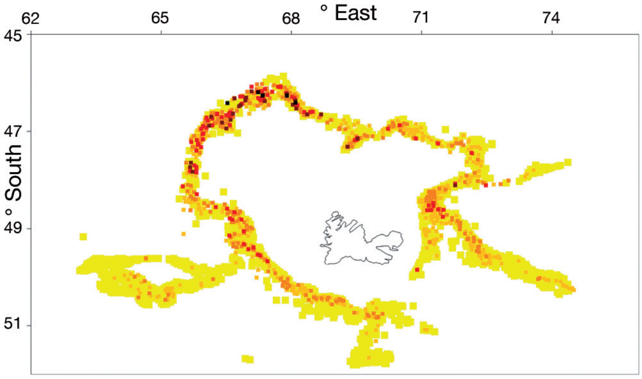

Figure 8. - Wandering albatross (*Diomedea exulans* L. 1758) distribution derived from fisheries observer data in the Kerguelen EEZ, from highest (black dots) to lowest (yellow) densities.

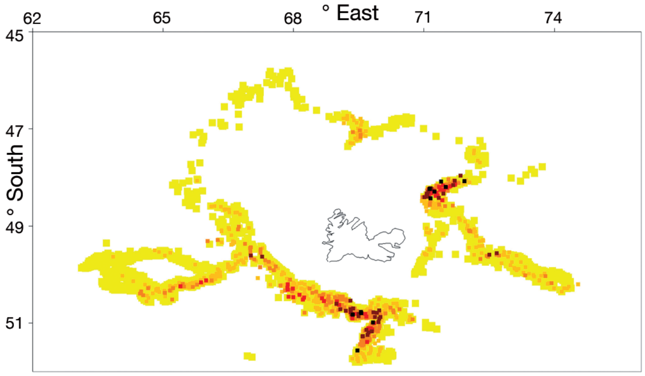

Figure 9. - Fur seal (*Arctocephalus* spp.) distribution derived from fisheries observer data in the Kerguelen EEZ, from highest (black dots) to lowest (yellow) densities.

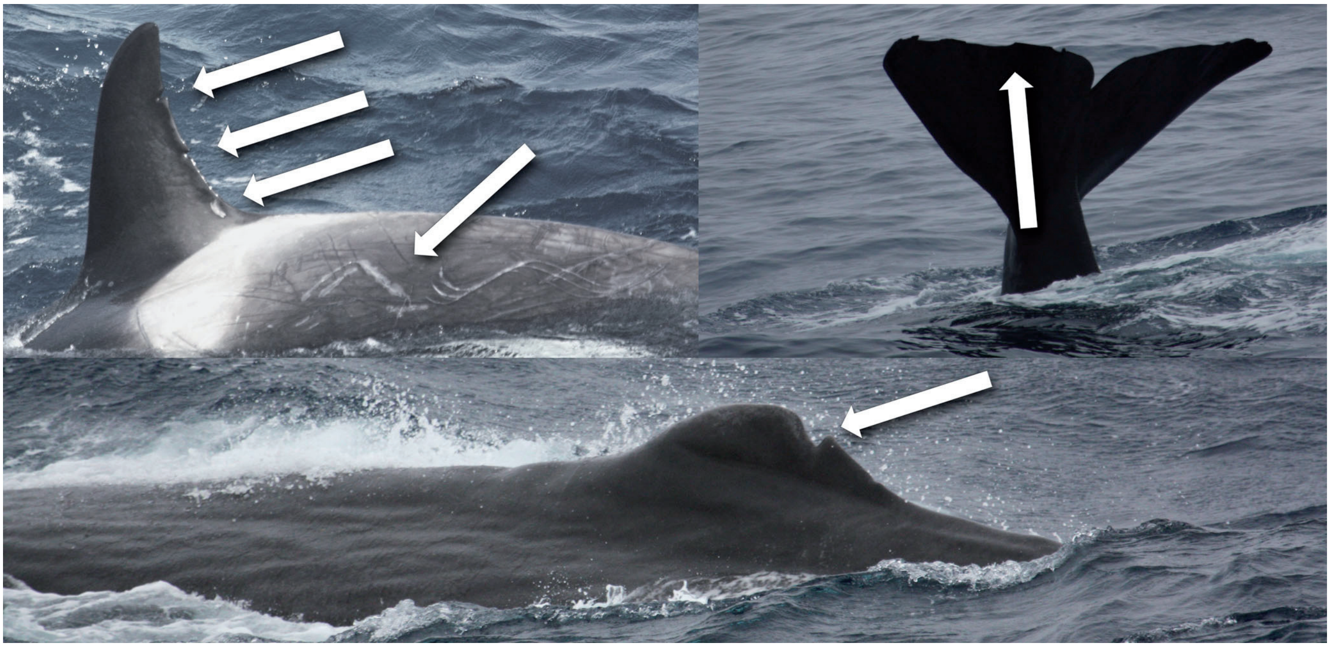

Figure 10. - Examples of killer (top left) and sperm whales identification by key points.

are trained to identify and count the birds around the vessel at regular intervals. The counts are used as an abundance index, providing spatial distribution of the main species interacting with the fishing vessels. Densities observed also have the potential to provide independent verification of satellite tracking data (Fig. 8).

Bird bands

Observers occasionally see birds with either metal or plastic bands around their legs. Plastic bands can be read at sea through photos taken when birds land on water close to the boat. Metal bands are recorded mainly on dead birds. This gives recapture information on different species, since many of these bird species travel all around the Antarctic and the Southern Ocean.

Mammals

Sperm whales (*Physeter macrocephalus* Linnaeus 1758), Orcas (*Orcinus orca* Linnaeus 1758) and Fur seals (*Arctocephalus* spp.) are the primary mammal species encountered around fishing vessels. These species are attracted by foraging opportunities provided by the fishing activities, but their natural forage areas also co-occur with the fishing grounds. For each haul, observers count the different species around the vessel whenever weather and lighting conditions permit.

These datasets are used to calculate depredation rate (how much fish is taken off the line) through comparisons of the difference in catch rate with and without mammals present (Tixier, 2008; Tixier *et al.*, 2010). It also gives information on the spatial and temporal distribution of the species. An example of distribution is shown for Fur seals (Fig. 9).

Another notable feature of marine mammals such as whales is the scratches on their body, in particular, on the dorsal fin, saddle patch and tail (Fig. 10). Like our fingerprints, this can be used to uniquely identify individuals. This work is carried-out by observers taking photographs of the animals.

This information is used to analyse demography and movement (Roche *et al*., 2007; Tixier *et al*., 2010).

CONCLUSION

Observers provide a lot of scientific data from a remote area under difficult working conditions, enabling a lot of novel scientific studies to be completed, which would have been impossible or prohibitively expensive if they were attempted from conventional research platforms such as research voyages alone. Therefore, it is important to recognise and highlight these contributions that significantly add to the scientific understanding of fisheries and ecosystems in the Kerguelen region.

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